Evaluation of the efficacy of the forearm basilic vein transposition arteriovenous fistula

Hae-Jung Son, MD, Seung-Kee Min, MD, PhD, Sang-Il Min, MD, Yang Jin Park, MD, Jongwon Ha, MD, PhD, and **Sang Joon Kim, MD, PhD,** *Seoul, Korea*

Purpose: **Since the publication of Dialysis Outcomes Quality Initiative (DOQI) guidelines, the use of native veins for the construction of arteriovenous fistulas (AVF) for hemodialysis has been highly recommended rather than prosthetic arteriovenous grafts (AVG). Upper arm basilic vein transposition (BVT) has been accepted widely, with superior patency compared with AVG, but only a few studies have reported outcomes of forearm BVT (FBVT). This study evaluated the efficacy of FBVT compared with direct AVF (DAVF) and AVG in a tertiary referral center.**
Methods: **From January 2005 to December 2007, 461 patients underwent AV access for hemodialysis in Seoul National University Hospital. We retrospectively reviewed the medical records and dialysis sheets and evaluated the current AVF function in the outpatient clinic or by telephone interviews. Patients were grouped by the operation type: DAVF, FBVT, and AVG. The outcomes compared were primary, assisted-primary and secondary patency rates, maturation failure, and complications.**
Result: **The mean age was 59 years (range, 14-92 years), and 280 patients (60.7%) were male. By operation type, the 461 accesses were 389 DAVF (84.4%), 34 FBVT (7.4%), and 38 AVG (8.2%). Mean follow-up duration was 21 months (range, 1-51 months). The primary patency rates for DAVF, FBVT, and AVG were 67.6%, 41.5%, 35% at 12 months and 53.9%, 30.2%, 10.3% at 24 months, respectively. The secondary patency rates were 89.2%, 79.1%, 78.3% at 12 months and 83.8%, 74.4%, 64.9% at 24 months, respectively. Maturation failure occurred in five DAVF patients and in one FBVT patient. The infection rate was 0.3% in DAVF and 12.5% in AVG, but no infection occurred in patients with FBVT. Multivariate analysis revealed that age and history of previous access were associated with lower primary patency.**
Conclusion: **Forearm BVT showed an acceptable, high 2-year patency rate and fewer thromboses and infectious complications than AVG. Forearm BVT could be considered before forming an upper arm AVF or forearm AVG, if the basilic vein is available. (J Vasc Surg 2010;51:667-72.)**

It is essential to secure and maintain vascular access for proper dialysis in patients receiving maintenance hemodialysis. The ideal vascular access should be durable, have minimal risk of infection, and require few interventions to maintain patency. The National Kidney Foundation Dialysis Outcome Quality Initiative (NKF K/DOQI) guidelines published in 1997 encouraged the use of autogenous arteriovenous fistulas (AVFs), emphasizing that they could maintain long life spans with minimal complications and interventions.[1] According to the guideline, autogenous AVFs have been preferred over prosthetic arteriovenous grafts (AVGs).

The formation of an AVF through upper arm basilic vein transposition (UBVT) is another method of using autogenous vessels and has been attempted by many groups.[2-9] Although this method has some disadvantages, including technical difficulty, longer operation times, and longer maturation duration, it is widely accepted because of better patency rates and fewer infection rates compared with prosthetic grafts.

Few studies have been done on the patency rates of forearm BVT (FBVT).[10-12] We thought that forearm basilic vein could be used as an alternative for UBVT, providing another option for autogenous hemodialysis access. It could be used in patients with failed direct AVFs (DAVFs), such as radial-cephalic direct wrist access or brachial-cephalic upper arm direct access. With the initial successes performing FBVT in our hospital, we hypothesized that FBVT could be done safely with an acceptable long-term patency and few complications. The purpose of this study was to evaluate the efficacy of FBVT compared with DAVF and AVG in a single tertiary referral center.

METHODS

From January 2005 through December 2007, 461 patients underwent AV access for hemodialysis in Seoul National University Hospital. The medical records and dialysis records were retrospectively reviewed, and current AVF function was evaluated in the outpatient clinic or by telephone interviews. Patients were grouped by the operation type: DAVF, FBVT, or AVG. The DAVF group included autogenous radial-cephalic and brachial-cephalic AVFs, and AVG included forearm straight or loop grafts.

For the FBVT, careful physical examinations and duplex ultrasound (DUS) imaging were conducted to determine whether a forearm basilic vein could be used, with the criteria being a basilic vein diameter >2.5 mm throughout

From the Department of Surgery, Seoul National University College of Medicine.
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Reprint requests: Seung-Kee Min, MD, PhD, Department of Surgery, Seoul National University College of Medicine, 101 Daehang-Ro, Jongno-Gu, Seoul, 110-744, Republic of Korea (e-mail: skminmd@snuh.org).
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Fig 1. A, Operative field is shown after dissection of the forearm basilic vein. Separate skin incisions were made along the basilic vein from wrist to elbow. The basilic vein was transposed to the volar side of the forearm through a subcutaneous tunnel. An end-to-side anastomosis was made with the radial artery at the wrist. **B,** Operative field is shown after closure.

the length on the forearm, without stenosis or fibrosis. For the DAVF, the same preoperative evaluation and criteria were applied to the cephalic vein.

For the transposition of the forearm basilic vein, three or four separate skin incisions were made under local anesthesia from the antecubital fossa to the wrist, and the basilic vein was dissected free. The radial artery at the wrist was exposed. The basilic vein was transposed through a subcutaneous tunnel on the volar aspects of the forearm, and an end-to-side anastomosis was performed with the radial artery (Fig 1). The vein was marked before it was passed through the tunnel to prevent kinking or twisting.

The outcomes of function and patency were evaluated, including primary, assisted primary, and secondary patency rates, maturation failure, and complications. Maturation failure was defined as early occlusion or unsuitable for hemodialysis 8 weeks after the AV access creation. The primary, assisted-primary, and secondary patency rates were defined according to the Society for Vascular Surgery guideline.[3]

The data are expressed as mean ± standard deviation. Patient characteristics were compared by the Mann-Whitney and χ^2 tests. Patency rates were evaluated using Kaplan-Meier plots and compared using log-rank analysis. A value of $P < .05$ was considered statistically significant. Statistical analysis was performed using SPSS 12.0 software (SPSS Inc, Chicago, Ill).

RESULTS

Patient demographics. The mean age was 59 ± 15.1 years, and there were 280 men (60.7%) and 181 women (39.2%). The 461 cases included 389 DAVFs (84.4%), 34 FBVTs (7.3%), and 38 AVGs (8.2%). Direct AVFs included 300 radial-cephalic AVFs and 89 brachial-cephalic AVFs. The follow-up period was 21.6 ± 12.6 months (range, 1-51 months). The patients in the DAVF group were significantly younger (58.5 ± 14.9 vs 66.7 ± 12.5 years, $P =$ .001), had fewer cardiovascular or cerebrovascular diseases, and had undergone fewer previous vascular accesses for dialysis than the patients in the AVG group (Table I). Diabetes and hypertension were the most frequent cause of renal failure in all groups.

Patency rates. The average primary patency periods were 29.4 ± 1.2 months in the DAVF group, 16.9 ± 2.9 in the FBVT group, and 12.6 ± 1.9 in the AVG group. The DAVF group showed better patency than the FBVT or AVG groups ($P < .005$). The difference between the primary patencies of the FBVT and AVG groups was not statistically significant ($P = .238$), although the period was longer in the FBVT group. The 12-month primary patency rates of DAVFs, FBVTs, and AVGs were 67.6%, 41.5%, and 35.0%, respectively (Fig 2). The 24-month primary patency rates were 53.9%, 30.2 %, and 10.3%, respectively. The primary-assisted patency rates were 88.6%, 79.1%, and 75.6% at 12 months and 82.5%, 74.4%, and 65.5% at 24 months (Fig 3). The secondary patency rates were 89.2%, 79.1%, and 78.3%, respectively, at 12 months and 83.8%, 74.4%, and 64.9% at 24 months (Fig 4).

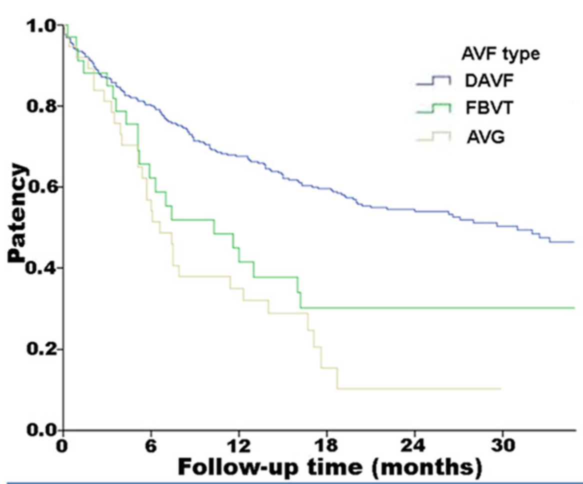
The direct AVF group included 300 radial-cephalic AVFs (RC-AVFs) and 89 brachial-cephalic AVFs (BC-AVFs). The patencies in each subgroup were compared with FBVT. The primary, assisted-primary, and secondary patency periods of the BC-AVF subgroup were 30.4 ± 2.5, 44.2 ± 1.9 and 44.3 ± 1.9, respectively. The primary, assisted-primary, and secondary patency periods of the RC-AVF subgroup were 28.0 ± 1.3, 41.3 ± 1.1, and 47.8 ± 1.7, respectively. The differences in the patency rates between BC-AVF and RC-AVF patients were not statistically significant. In comparison with the FBVT subgroup, the BC-AVF and RC-AVF subgroups both showed better primary patency ($P < .01$), although primary-assisted and secondary patencies were not different.

Risk factors such as age, gender, diabetes, hypertension, cerebrovascular disease, previous access history, and access type were analyzed with logistic regression. Primary patency rates were significantly lower in patients aged >60

Table I. Patient demographics and clinical data

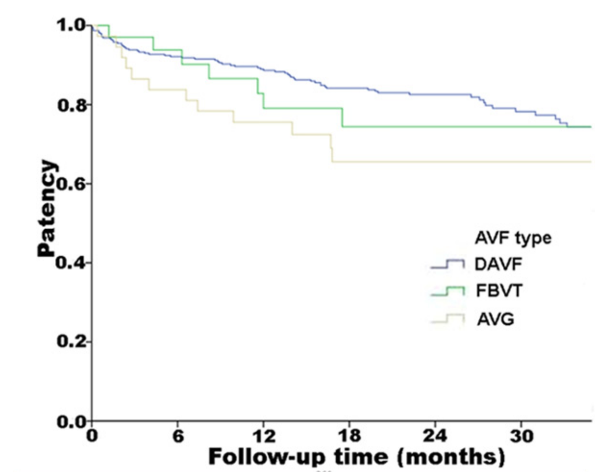
Characteristic	*DAVF*	*FBVT*	*AVG*	P *value*
Type of access, No. (%)	389 (84.4)	34 (7.4)	38 (8.2)	
Age, y				
Mean ± SD	58.54 ± 15.35[a]	62.29 ± 11.84	66.87 ± 12.44[a]	<.001
Range	14-92	32-81	24-86	
Gender, No. (%)				
Male	232 (59.6)	24 (70.6)	24 (63.2)	NS
Female	157 (40.4)	10 (29.4)	14 (36.8)	
Follow-up interval, mon				
Mean ± SD	15.39 ± 9.46	17.42 ± 10.99	16.65 ± 7.38	NS
Range	1-40.8	1.5-41.6	5.1-39.4	
Comorbidities, No. (%)				
Diabetes	193 (49.6)	18 (52.9)	24 (63.2)	NS
Hypertension	321 (82.7)	24 (70.6)	33 (86.8)	NS
CAD	72 (18.6)[a]	9 (30.0)	13 (34.2)[a]	.022
CVD	34 (8.8)[a]	3 (8.8)	13 (34.2)[a]	.008
Etiology of renal failure				
Diabetes	184 (47.3)	18 (52.9)	21 (55.3)	NS
Hypertension	37 (9.5)	4 (11.8)	5 (13.2)	NS
IgA nephropathy	21 (5.4)	0 (0)	1 (2.6)	NS
Unknown	59 (15.2)	2 (5.9)	5 (13.2)	NS
Others	88 (22.6)	10 (29.4)	6 (15.7)	NS

AVG, Arteriovenous graft (prosthetic); *CAD,* coronary artery disease; *CVD,* cerebrovascular disease; *DAVF,* direct arteriovenous fistula; *FBVT,* forearm basilic vein transposition; *IgA,* immunoglobulin A; *SD,* standard deviation.
[a]The *P* value is the result of comparison between the marked groups.



Patient at risk					
DAVF	269	206	158	99	60
FBVT	18	12	8	6	3
AVG	20	12	3	2	0

Fig 2. Kaplan-Meier curves show primary patency rates for direct arteriovenous fistulas *(DAVFs)*, forearm basilic vein transpositions *(FBVTs)*, and prosthetic arteriovenous grafts *(AVGs)*.

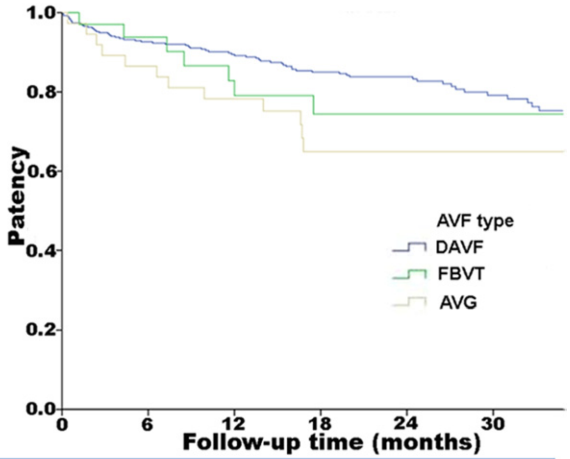


Patient at risk					
DAVF	307	271	224	154	93
FBVT	26	21	16	10	6
AVG	31	26	16	6	1

Fig 3. Kaplan-Meier curves show primary-assisted patency rates for direct arteriovenous fistulas *(DAVFs)*, forearm basilic vein transpositions *(FBVTs)*, and prosthetic arteriovenous grafts *(AVGs)*.

years, in patients who had previous vascular access, and in patients with access other than a DAVF (Table II).

Maturation failure and other complications. Maturation failure until 8 weeks postoperatively developed in 15 patients: 10 AVF patients (2.5%) and in five BVT patients (14.7%; Table III). Among them, new access operations were performed in four patients, three in the AVF group, and one in the BVT group. Infection developed in one AVF patient and in five AVG patients. Importantly, there were no infectious complications in the BVT group. Wound seroma or hematoma developed in one AVF and in one BVT patient, which were treated by minor drainage



Patient at risk					
DAVF	309	273	227	157	95
FBVT	26	21	16	10	6
AVG	32	27	16	6	1

Fig 4. Kaplan-Meier curves show of secondary patency rates for direct arteriovenous fistulas *(DAVFs)*, forearm basilic vein transpositions *(FBVTs)*, and prosthetic arteriovenous grafts *(AVGs)*.

procedures. Compared with DAVFs, FBVTs showed a significantly higher maturation failure rate of 14.7% vs 2.5% ($P = .004$). Compared with AVGs, FBVTs showed significantly fewer thrombosis and infection ($P < .001$).

DISCUSSION

Thanks to the development of medical technology, the mean age of patients depending on dialysis has increased, and the lifespan of patients with renal failure has also increased, making the preservation of vessels for vascular access more important. Although direct autogenous AVFs on the wrist or the antecubital fossa are the most preferred, sometimes vascular conditions are not suitable due to damage caused by frequent injections, previous vascular access operations, or old age. The AVF made through venous transposition has been regarded as another way to use autogenous vessels following the NKF-DOQI recommendation[1] that actively encouraged the use of autogenous vessels. The use of upper arm BVT (UBVT) was first published by Dagher et al[2] in 1976. This AVF has the advantage of a higher patency rate than that of prosthetic grafts and a lower infection rate.[5-7] However, the disadvantages include longer operation time, longer maturation period required, possible vein damage during dissection, and frequent wound problems owing to the longer incision. The 1-year primary patency rates of the UBVT are reported as 23% to 90%, whereas 1-year secondary patency rates are 47% to 96%.[3-9] On the basis of these reports, UBVT is now widely accepted for a permanent hemodialysis access.[4-9] However, there are few reports on the patency rate of forearm BVT (FBVT).[10-12] Although only 10 cases were included in a retrospective study, Gormus et al[10] reported a 90% patency rate for FBVT at 10 months and 80% for UBVT. Weyde et al[11] reported patency rates of FBVT as 70.4% at 1 year and 48.4% at 3 years.

The 12- and 24-month primary patency rates of the FBVTs in our series were 41.5% and 30.2%, which were relatively low. However, the primary-assisted patency rates were 79.1% and 74.4%, and the secondary patency rates were 79.1% and 74.4%, respectively. The low primary patency rates could be interpreted as the consequence of our hospital policy to perform active surveillance and early intervention. Our periodic surveillance program uses duplex ultrasound imaging when the arterial flow is <300 mL/min during dialysis, and balloon angioplasty is performed when there is any stenosis.

One FBVT thrombosed during the follow-up period. The patient had diffuse stenosis of the AVF, and a new brachial-cephalic AVF was created on the upper arm. This can explain the same primary-assisted patency and secondary patency rates. The patency rates of direct AVFs are better than those of FBVTs or AVGs. The overall patency rate of FBVTs was statistically similar to that of AVGs, although the patency period was longer in FBVTs. We suspect that this can be a type II statistical error because of the small sample size, which should be proved in further studies. Complications such as thrombosis and infection were significantly less frequent in patients with BVTs than in those with AVGs.

The maturation failure rate of the FBVT is 14.7%, which is higher than that of the DAVF (2.5%). However, most are salvageable by percutaneous intervention, and only one patient needed reoperation. Others have reported reoperation rates of 20% to 40% before the first use of an AVF,[13-15] and 6% to 23% for UBVTs.[16-18]

Meanwhile, forearm or upper arm BVT is believed to be subject to many technical complications, such as wound complications, due to the long incision and vein kinking or twisting during tunneling. We can, however, minimize those problems with meticulous surgical technique, as described above.

We had no patient with a UBVT during the study period. In cases unsuitable for direct a AVF or FBVT, we asked the patient to choose the access type between the two options of UBVT or forearm AVG. Because of the deep location of the upper arm basilic vein, we usually performed the UBVT under general anesthesia, to which most of the patients were reluctant.

On the basis of these results, we perform FBVT preferentially when a radial-cephalic AVF fails or when a forearm cephalic vein is not suitable. Fistulas using brachial artery inflow, such as a brachial-cephalic AVF or a forearm loop graft, can be reserved for future use. The rationales for performing an FBVT before an AVG can be summarized as follows: First, the patency rate of the FBVT is comparable with that of an AVG. Second, infectious complication is far less in a BVT. Third, even if the FBVT does not increase in size enough to be used for dialysis, it may contribute to a larger upper arm basilic vein, which then could be used for long-term dialysis. And finally, when FBVT fails, a forearm

Table II. Multivariate analysis of factors associated with the risk of low primary and secondary patency rates

	Primary patency		*Secondary patency*	
Covariate	*aRR (95% CI)*	P *value*	*aRR (95% CI)*	P *value*
Old age	1.015 (1.004-1.026)	.006	1.022 (1.005-1.039)	.009
Female sex	1.102 (0.827-1.467)	.507	0.868 (0.552-1.363)	.538
Diabetes	0.912 (0.685-1.213)	.527	0.769 (0.494-1.196)	.244
Hypertension	0.891 (0.615-1.291)	.541	0.795 (0.452-1.399)	.426
CVD	1.073 (0.682-1.688)	.760	1.394 (0.740-2.623)	.304
Previous access	1.514 (1.110-2.065)	.009	0.775 (0.452-1.329)	.354
Access type				
DAVF	1		1	
FBVT	1.667 (1.045-2.660)	.032	1.348 (0.627-2.902)	.445
AVG	2.165 (1.417-3.308)	<.001	1.946 (1.008-3.759)	.047

aRR, Adjusted relative risk; *AVG,* prosthetic arteriovenous graft; *CI,* confidence interval; *CVD,* cerebrovascular disease; *DAVF,* direct arteriovenous fistula; *FBVT,* forearm basilic vein transposition.

Table III. Complications during the follow-up

Complication[a]	*DAVF*	*FBVT*	*AVG*	P *value*
Maturation failure	10 (2.5)[a]	5 (14.7)[a]	0	.004
Thrombosis	11 (2.8)	1 (2.9)[a]	10 (26.3)[a]	<.001
Seroma/hematoma	1 (0.03)	1 (2.9)	0	NS
Infection	1 (0.03)	0[a]	5 (13.2)[a]	<.001
Steal syndrome	1 (0.03)	0	0	NS

AVG, prosthetic arteriovenous graft; *DAVF,* direct arteriovenous fistula; *FBVT,* forearm basilic vein transposition; *NS,* not significant.
[a]The *P* value is the result of comparison between the marked groups.

AVG can be the next option, but the reverse is not usually possible. The remaining concern about the FBVT is the high maturation failure rate. We think this can be reduced with careful patient selection. Early intervention of the stenotic segment can achieve maturation, as in our series.

To increase the use of the FBVT, careful examination for the presence of a forearm basilic vein by a vascular surgeon is very important. Frequently, uninjured forearm basilic vein could be found and offered a good conduit for long-term hemodialysis.

CONCLUSION

This study shows that the forearm basilic vein transposition has an acceptable, high 2-year patency rate and fewer complications than expected. For patients with a failed wrist radial-cephalic AVF or no suitable forearm cephalic vein, the presence of a forearm basilic vein should be examined. Formation of a forearm basilic vein transposition AVF could be considered before forming an upper arm AVF or a forearm prosthetic graft.

AUTHOR CONTRIBUTIONS

Conception and design: SKM, JH
Analysis and interpretation: HS, SKM, SIM
Data collection: HS, SIM, YP
Writing the article: HS, SKM
Critical revision of the article: SKM, JH, SK
Final approval of the article: HS, SKM, SIM, YP, JH, SK
Statistical analysis: HS, SKM, YP
Obtained funding: Not applicable
Overall responsibility: SKM

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